



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: In Situ Experimental Analysis and Modeling of Diesel Fuel Bioremediation in a Tidally Influenced Aquifer

Duration: August 1, 1997 through July 31, 1999

Federal funds requested: \$47,142

Non-Federal (matching) funds pledged: \$94,395

Principal Investigators' Names, University, City, and Water Resource Institute:

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Congressional district of university where the research is to be conducted: First

Statement of critical regional water problems:

In situ bioremediation of petroleum hydrocarbon pollutants in aquifers is a technique which is receiving increasing attention as an alternative, or an adjunct, to the costly pump-and-treat process to decontaminate groundwater and subsurface matrix (Semprini et al., 1991; Devlin and Barker, 1994; Aggarwal et al., 1991). The Environmental Protection Agency is encouraging the use of bioremediation in the field (Kremer and Kovalick, 1991). Indigenous microbial populations have the potential to transform petroleum hydrocarbons to non-noxious products such as water, carbon dioxide, and minerals. However, they must be supplied with enough oxygen and inorganic nutrients (nitrogen, phosphorus, micronutrients) to be able to incorporate the organic carbon into microbial biomass (Aggarwal et al., 1991; Atlas, 1991). The advantage of microbial degradation lies in the ubiquity of microorganisms, which enables them to act on pollutants located in hard-to-reach areas and in areas where the pollutants are trapped in the subsurface matrix. A need exists to examine the suitability of this technique for the cleanup of nearshore aquifers, such as those of the Hawaiian islands. Coastal areas includes a number of sites where significant plumes of free products are known to be present in the subsurface. Some of the documented sites are the Gray Line Site, Honolulu Harbor area, Honolulu International Airport, Hickam Air Force Base, Pearl Harbor Naval Complex, and Campbell Industrial Park (R.D. Brewer, Hawaii Department of Health; personal communication, 1996). All of these sites are known to have impacted or could potentially impact the sensitive marine areas. An urgent need exists to assess the potential of bioremediation in such aquifers as an important step toward the utilization of such techniques. State agencies will surely benefit directly from such research. The results obtained can be also very beneficial on the national level because of the existence of similar problems nationwide.

Statement of the results, benefits, and/or information expected to be gained:

This research is critical in assessing the fate of hydrocarbons in a nearshore subsurface environment. A specific and well-documented site will be used in the analysis. The fate of the product and its dissolved phase will be predicted to identify the urgency of Remediation. A laboratory experiment is currently in progress with a tide simulator under controlled conditions to assess the potential of such an approach as a viable field technique. In this proposed project, a field experiment will be performed to adapt the bioremediation parameters to the in situ conditions. The results are expected to be of great benefit on both the basic and applied research levels. The results will be published in scientific journals and will be submitted to local and state agencies, especially the Department of Health, for their use in assessing various contaminated sites of the same nature.

The in-situ project will determine the effect of a full bioremediation program (addition of nutrients and oxygen) on the rate of biodegradation of diesel fuel contaminant in a tidally influenced aquifer around 21°C in comparison with degradation under no-treatment conditions. It will also correlate the disappearance of hydrocarbons and the activity of hydrocarbonoclastic microorganisms in the sediment. The pattern of the decrease of hydrocarbon concentration with time (e.g., a rapid decrease at the beginning followed by a plateau or a slow, linear pattern) will be established and compared with the data obtained in the lab experiment. The fractions of diesel that are more recalcitrant to biodegradation, even in the improved environment, will be determined. Finally, the results in the field will be used to test the validity of the models which were developed on the basis of the data generated in the lab experiment during the first year. The information acquired in the in situ experiment will permit the development of a protocol for the enhancement of bioremediation of petroleum hydrocarbons under similar conditions not only in the Hawaiian islands but in other coastal regions.